

1 WHAT IS CLAIMED IS:

12 1. A composition comprising a polymeric backbone, cyclic olefinic pendent
3 groups and linking groups linking the olefinic pendent groups to the
4 polymeric backbone.

5 2. A composition according to claim 1, wherein the polymeric backbone is
6 ethylenic and the linking groups are selected from the group consisting
7 of:

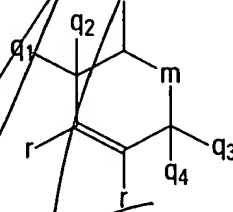
8 $-\text{O}-(\text{CHR})_n-$; $-(\text{C}=\text{O})-\text{O}-(\text{CHR})_n-$; $-\text{NH}-(\text{CHR})_n-$; $-\text{O}-(\text{C}=\text{O})-(\text{CHR})_n-$;

9 $-(\text{C}=\text{O})-\text{NH}-(\text{CHR})_n-$; and $-(\text{C}=\text{O})-\text{O}-\text{CHOH}-\text{CH}_2-\text{O}-$;

10 wherein R is hydrogen or an alkyl group selected from the group
11 consisting of methyl, ethyl, propyl and butyl groups and where n is an
12 integer in the range from 1 to 12.

13 3. The composition of claim 1, wherein the cyclic olefinic pendent groups
14 have the structure (I):

15 (I)

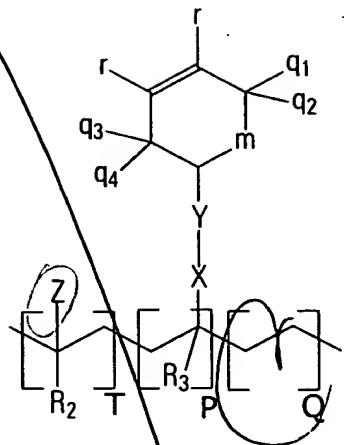


16
17
18 where q1, q2, q3, q4, and r are selected from the group consisting of -H, -
19 CH3, and -C2H5; and where m is $-(\text{CH}_2)_n-$ with n being an integer in the
20 range from 0 to 4; and wherein, when r is -H, at least one of q1, q2, q3
21 and q4 is -H.

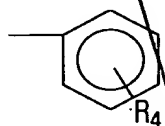
- 1 4. The ~~composition~~ of claim 1, wherein the polymeric backbone comprises
2 monomers selected from the group consisting of ethylene and styrene.
- 3 5. The ~~composition~~ of claim 1, wherein the cyclic olefinic pendent groups
4 are grafted onto the linking groups of the polymeric backbone by an
5 esterification, transesterification, amidation or transamidation reaction.
- 6 6. The ~~composition~~ of claim 5, wherein the esterification, transesterification,
7 amidation or transamidation reaction is a solution reaction or a reactive
8 extrusion.
- 9 7. The ~~composition~~ of claim 5, wherein the esterification, transesterification,
10 amidation or transamidation reaction is catalyzed by a catalyst selected
11 from the group consisting of strong non-oxidizing acids, tertiary amines,
12 Group I alkoxides, Group IVB alkoxides, and Group IVA organometallics.
- 13 8. The ~~composition~~ of claim 7, wherein the catalyst is selected from a
14 group consisting of toluene sulfonic acid, sodium methoxide, tetrabutyl
15 titanate, tetraisopropyl titanate, tetra-n-propyl-titanate, tetraethyl titanate,
16 2-hydroxy-pyridine and dibutyltin dilaurate.
- 17 9. The ~~composition~~ of claim 1, wherein the polymeric backbone, linking
18 groups and cyclic olefin pendent groups comprise repeating units, each
19 unit having a structure (II) as follows:

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(II)



wherein P+T+ Q is 100 mol % of the total composition; P is greater than 0 mol % of the total composition; Z is selected from the group consisting of an aryl group; $-(C=O)OR_1$; $-O(C=O)R_1$; and an alkyl aryl group:



where R_4 is selected from the group consisting of $-CH_3$, $-C_2H_5$, and $-H$; R_1 is selected from the group consisting of $-H$, $-CH_3$, $-C_2H_5$, $-C_3H_7$ and $-C_4H_9$; R_2 and R_3 are selected from the group consisting of $-H$ and $-CH_3$; X is selected from the group consisting of $-O-$, $-NH-$, $-(C=O)O-$, $-(C=O)NH-$, $-(C=O)S-$, $-O(C=O)-$ and $-(CHR)_l-$; l is an integer in the range from 1 to 6; Y is $-(CHR)_n-$, where n is an integer in the range from 0 to 12, R being selected from the group consisting of $-H$, $-CH_3$ and $-C_2H_5$; where q_1 , q_2 , q_3 , q_4 , and r are selected from the group consisting of $-H$, $-CH_3$, and $-C_2H_5$; and where m is $-(CH_2)_n-$ and where n is an

1 integer in the range from 0 to 4, and wherein when r is -H, at least one
2 of q₁, q₂, q₃ and q₄ is -H.

3 10. The composition of claim 9, wherein the cyclic olefinic pendent groups
4 are selected from the group consisting of cyclohexene-4-methylene
5 radical, 1-methyl cyclohexene-4-methylene radical, 2-methyl
6 cyclohexene-4-methylene radical, 5-methyl cyclohexene-4-methylene
7 radical, 1,2-dimethyl cyclohexene-4-methylene radical, 1,5-dimethyl
8 cyclohexene-4-methylene radical, 2,5-dimethyl cyclohexene-4-
9 methylene radical, 1,2,5-trimethyl cyclohexene-4-methylene radical,
10 cyclohexene-4-ethylene radical, 1-methyl cyclohexene-4-ethylene
11 radical, 2-methyl cyclohexene-4-ethylene radical, 5-methyl cyclohexene-
12 4-ethylene radical, 1,2-dimethyl cyclohexene-4-ethylene radical, 1,5-
13 dimethyl cyclohexene-4-ethylene radical, 2,5-dimethyl cyclohexene-4-
14 ethylene radical, 1,2,5-trimethyl cyclohexene-4-ethylene radical,
15 cyclohexene-4-propylene radical, 1-methyl cyclohexene-4-propylene
16 radical, 2-methyl cyclohexene-4-propylene radical, 5-methyl
17 cyclohexene-4-propylene radical, 1,2-dimethyl cyclohexene-4-propylene
18 radical, 1,5-dimethyl cyclohexene-4-propylene radical, 2,5-dimethyl
19 cyclohexene-4-propylene radical, 1,2,5-trimethyl cyclohexene-4-
20 propylene radical, cyclopentene-4-methylene radical, 1-methyl
21 cyclopentene-4-methylene radical, 3-methyl cyclopentene-4-methylene
22 radical, 1,2-dimethyl cyclopentene-4-methylene radical, 3,5-dimethyl
23 cyclopentene-4-methylene radical, 1,3-dimethyl cyclopentene-4-
24 methylene radical, 2,3-dimethyl cyclopentene-4-methylene radical, 1,2,3-
25 trimethyl cyclopentene-4-methylene radical, 1,2,3,5-tetramethyl
26 cyclopentene-4-methylene radical, cyclopentene-4-ethylene radical, 1-
27 methyl cyclopentene-4-ethylene radical, 3-methyl cyclopentene-4-
28 ethylene radical, 1,2-dimethyl cyclopentene-4-ethylene radical, 3,5-
29 dimethyl cyclopentene-4-ethylene radical, 1,3-dimethyl cyclopentene-4-
30 ethylene radical, 2,3-dimethyl cyclopentene-4-ethylene radical, 1,2,3-
31 trimethyl cyclopentene-4-ethylene radical, 1,2,3,5-tetramethyl

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1 cyclopentene-4-ethylene radical, cyclopentene-4-propylene radical, 1-
2 methyl cyclopentene-4-propylene radical, 3-methyl cyclopentene-4-
3 propylene radical, 1,2-dimethyl cyclopentene-4-propylene radical, 3,5-
4 dimethyl cyclopentene-4-propylene radical, 1,3-dimethyl cyclopentene-4-
5 propylene radical, 2,3-dimethyl cyclopentene-4-propylene radical, 1,2,3-
6 trimethyl cyclopentene-4-propylene radical, and 1,2,3,5-tetramethyl
7 cyclopentene-4-propylene radical.

8 11. The ~~composition~~ of claim 9, wherein the composition is an
9 ethylene/methyl acrylate/cyclohexenyl methyl acrylate terpolymer, a
10 cyclohexenyl methyl acrylate/ethylene copolymer, a cyclohexenyl methyl
11 methacrylate/styrene copolymer, a cyclohexenyl methyl acrylate
12 homopolymer or a methyl acrylate/cyclohexenyl methyl acrylate
13 copolymer.

14 12. An oxygen scavenging composition comprising a polymeric backbone,
15 cyclic olefinic pendent groups, linking groups linking the olefinic pendent
16 groups to the polymeric backbone and a transition metal catalyst.

17 13. A composition according to claim 12, wherein the polymeric backbone is
18 ethylenic and the linking groups are selected from the group consisting
19 of:

20 $-O-(CHR)_n-$; $-(C=O)-O-(CHR)_n-$; $-NH-(CHR)_n-$; $-O-(C=O)-(CHR)_n-$;

21 $-(C=O)-NH-(CHR)_n-$; and $-(C=O)-O-CHOH-CH_2-O-$;

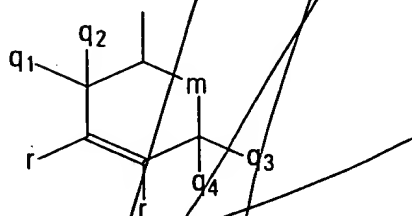
22 wherein R is hydrogen or an alkyl group selected from the group
23 consisting of methyl, ethyl, propyl and butyl groups and where n is an
24 integer in the range from 1 to 12.

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- 1 14. The composition of claim 12, wherein the cyclic olefinic pendent groups
2 have the structure (I):

3 (I)



6
7 where q_1 , q_2 , q_3 , q_4 , and r are selected from the group consisting of $-H$,
8 $-CH_3$, and $-C_2H_5$; and where m is $-(CH_2)_n-$ with n being an integer in the
9 range from 0 to 4; and wherein, when r is $-H$, at least one of q_1 , q_2 , q_3
10 and q_4 is $-H$.

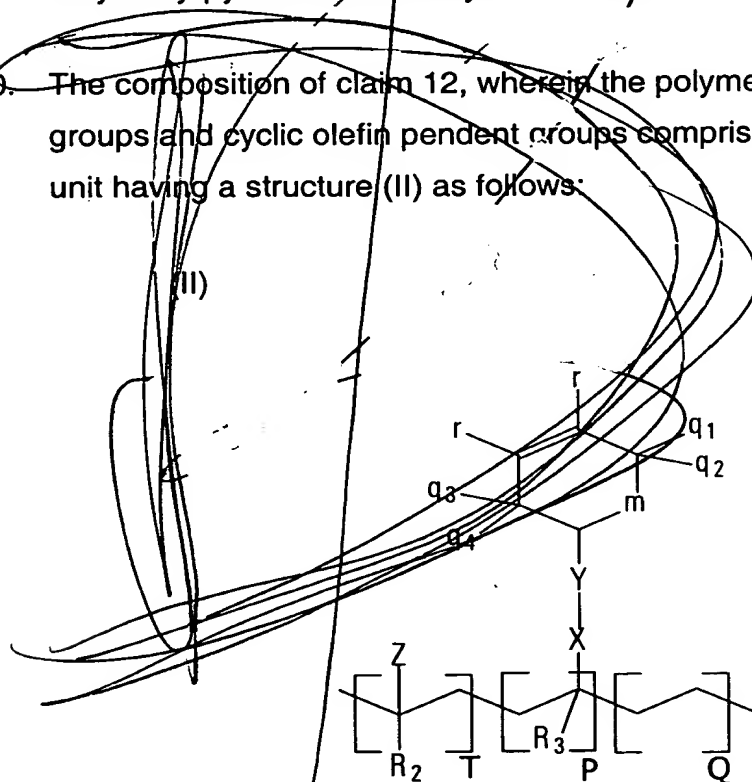
- 11 15. The composition of claim 12, wherein the polymeric backbone comprises
12 monomers selected from the group consisting of ethylene and styrene.
- 13 16. The composition of claim 12, wherein the cyclic olefinic pendent groups
14 are grafted onto the linking groups of the polymeric backbone by a
15 esterification, transesterification, amidation or transamidation reaction.
- 16 17. The composition of claim 16, wherein the esterification,
17 transesterification, amidation or transamidation reaction is a solution
18 reaction or a reactive extrusion.

1 18. The composition of claim 16, wherein the esterification,
2 transesterification, amidation or transamidation reaction is catalyzed by
3 a catalyst selected from the group consisting of strong non-oxidizing
4 acids, tertiary amines, Group I alkoxides, Group IVB alkoxides, and
5 Group IVA organometallics.

6 19. The composition of claim 18, wherein the catalyst is selected from a
7 group consisting of toluene sulfonic acid, sodium methoxide, tetrabutyl
8 titanate, tetraisopropyl titanate, tetra-n-propyl-titanate, tetraethyl titanate,
9 2-hydroxy-pyridine and dibutyltin dilaurate.

10 20. The composition of claim 12, wherein the polymeric backbone, linking
11 groups and cyclic olefin pendent groups comprise repeating units, each
12 unit having a structure (II) as follows:

13



14

15 wherein P + T + Q is 100 mol % of the total composition; P is greater
16 than 0 mol % of the total composition; Z is selected from the group
17 consisting of an aryl group; -(C=O)OR₁; -O(C=O)R₁; and an alkyl aryl
18 group:



1

2 where R_4 is selected from the group consisting of $-\text{CH}_3$, $-\text{C}_2\text{H}_5$, and $-\text{H}$;
 3 R_1 is selected from the group consisting of $-\text{H}$, $-\text{CH}_3$, $-\text{C}_2\text{H}_5$, $-\text{C}_3\text{H}_7$ and
 4 $-\text{C}_4\text{H}_9$; R_2 and R_3 are selected from the group consisting of $-\text{H}$ and $-\text{CH}_3$;
 5 X is selected from the group consisting of $-\text{O}-$, $-\text{NH}-$, $-(\text{C}=\text{O})\text{O}-$,
 6 $-(\text{C}=\text{O})\text{NH}-$, $-(\text{C}=\text{O})\text{S}-$, $-\text{O}(\text{C}=\text{O})-$ and $-(\text{CHR})_\ell-$; ℓ is an integer in the
 7 range from 1 to 6; Y is $-(\text{CHR})_n-$, where n is an integer in the range from
 8 0 to 12, R being selected from the group consisting of $-\text{H}$, $-\text{CH}_3$ and
 9 $-\text{C}_2\text{H}_5$; where q_1 , q_2 , q_3 , q_4 , and r are selected from the group consisting
 10 of $-\text{H}$, $-\text{CH}_3$, and $-\text{C}_2\text{H}_5$; and where m is $-(\text{CH}_2)_n-$ and where n is an
 11 integer in the range from 0 to 4; and wherein when r is $-\text{H}$, at least one
 12 of q_1 , q_2 , q_3 and q_4 is $-\text{H}$.

13 21. The composition of claim 20, wherein the cyclic olefinic pendent groups
 14 are selected from the group consisting of cyclohexene-4-methylene
 15 radical, 1-methyl cyclohexene-4-methylene radical, 2-methyl
 16 cyclohexene-4-methylene radical, 5-methyl cyclohexene-4-methylene
 17 radical, 1,2-dimethyl cyclohexene-4-methylene radical, 1,5-dimethyl
 18 cyclohexene-4-methylene radical, 2,5-dimethyl cyclohexene-4-methylene
 19 radical, 1,2,5-trimethyl cyclohexene-4-methylene radical, cyclohexene-4-
 20 ethylene radical, 1-methyl cyclohexene-4-ethylene radical, 2-methyl
 21 cyclohexene-4-ethylene radical, 5-methyl cyclohexene-4-ethylene
 22 radical, 1,2-dimethyl cyclohexene-4-ethylene radical, 1,5-dimethyl
 23 cyclohexene-4-ethylene radical, 2,5-dimethyl cyclohexene-4-ethylene
 24 radical, 1,2,5-trimethyl cyclohexene-4-ethylene radical, cyclohexene-4-
 25 propylene radical, 1-methyl cyclohexene-4-propylene radical, 2-methyl
 26 cyclohexene-4-propylene radical, 5-methyl cyclohexene-4-propylene
 27 radical, 1,2-dimethyl cyclohexene-4-propylene radical, 1,5-dimethyl

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1 cyclohexene-4-propylene radical, 2,5-dimethyl cyclohexene-4-propylene
2 radical, 1,2,5-trimethyl cyclohexene-4-propylene radical, cyclopentene-4-
3 methylene radical, 1-methyl cyclopentene-4-methylene radical, 3-methyl
4 cyclopentene-4-methylene radical, 1,2-dimethyl cyclopentene-4-
5 methylene radical, 3,5-dimethyl cyclopentene-4-methylene radical, 1,3-
6 dimethyl cyclopentene-4-methylene radical, 2,3-dimethyl cyclopentene-4-
7 methylene radical, 1,2,3-trimethyl cyclopentene-4-methylene radical,
8 1,2,3,5-tetramethyl cyclopentene-4-methylene radical, cyclopentene-4-
9 ethylene radical, 1-methyl cyclopentene-4-ethylene radical, 3-methyl
10 cyclopentene-4-ethylene radical, 1,2-dimethyl cyclopentene-4-ethylene
11 radical, 3,5-dimethyl cyclopentene-4-ethylene radical, 1,3-dimethyl
12 cyclopentene-4-ethylene radical, 2,3-dimethyl cyclopentene-4-ethylene
13 radical, 1,2,3-trimethyl cyclopentene-4-ethylene radical, 1,2,3,5-
14 tetramethyl cyclopentene-4-ethylene radical, cyclopentene-4-propylene
15 radical, 1-methyl cyclopentene-4-propylene radical, 3-methyl
16 cyclopentene-4-propylene radical, 1,2-dimethyl cyclopentene-4-
17 propylene radical, 3,5-dimethyl cyclopentene-4-propylene radical, 1,3-
18 dimethyl cyclopentene-4-propylene radical, 2,3-dimethyl cyclopentene-4-
19 propylene radical, 1,2,3-trimethyl cyclopentene-4-propylene radical, and
20 1,2,3,5-tetramethyl cyclopentene-4-propylene radical.

Sub 21 22. The composition of claim 20, wherein the composition is an
22 ethylene/methyl acrylate/cyclohexenyl methyl acrylate terpolymer, a
23 cyclohexenyl methyl acrylate/ethylene copolymer, a cyclohexenyl
24 methyl methacrylate/styrene copolymer, a cyclohexenyl methyl acrylate
25 homopolymer or a methyl acrylate/cyclohexenyl methyl acrylate
26 copolymer.

27 23. The composition of claim 12, wherein odor and taste characteristics of
28 products packaged with material comprised of the composition are not
29 adulterated as a result of oxidation of the composition.

1 24. The composition of claim 12, wherein there is no significant
2 fragmentation of the olefinic pendent groups and linking groups from the
3 polymeric backbone as a result of oxidation of the composition.

4 25. The composition of claim 12, wherein the transition metal catalyst is a
5 metal salt.

6 26. The composition of claim 25, wherein the metal in the metal salt is
7 cobalt.

8 27. The composition according to claim 25, wherein the metal salt is
9 selected from the group consisting of cobalt neodecanoate, cobalt
10 2-ethylhexanoate, cobalt oleate and cobalt stearate.

11 28. The composition of claim 12, further comprising at least one triggering
12 material to enhance initiation of oxygen scavenging.

13 29. The composition of claim 28, wherein the triggering material is a photo
14 initiator.

15 30. An article of manufacture suitable as a container, the container inhibiting
16 oxidation of contents of the container by removing oxygen from the
17 container and by inhibiting ingress of oxygen into the container from
18 outside the container, wherein the article comprises an oxygen
19 scavenging composition which comprises a polymeric backbone, cyclic
20 olefinic pendent groups, linking groups linking the olefinic pendent
21 groups to the backbone, and a transition metal catalyst.

22 31. The article of manufacture of claim 30, wherein the polymeric backbone
23 is ethylenic and the linking groups are selected from the group
24 consisting of:

25 $-O-(CHR)_n-$; $-(C=O)-O-(CHR)_n-$; $-NH-(CHR)_n-$; $-O-(C=O)-(CHR)_n-$;

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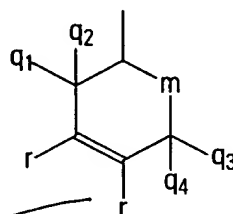
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1 $-(C=O)-NH-(CHR)_n-$; and $-(C=O)-O-CHOH-CH_2-O-$;

2 wherein R is hydrogen or an alkyl group selected from the group
3 consisting of methyl, ethyl, propyl and butyl groups and where n is an
4 integer in the range from 1 to 12.

5 32. The article of manufacture of claim 30, wherein the cyclic olefinic
6 pendent groups have the structure (I).

7 (I)

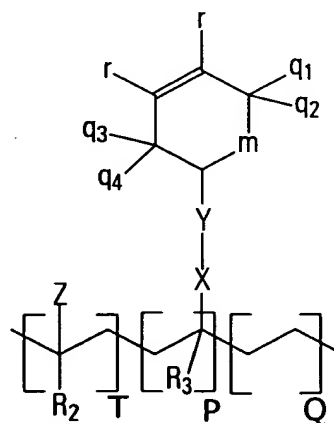


8
9 where q₁, q₂, q₃, q₄, and r are selected from the group consisting of -H,
10 -CH₃, and -C₂H₅, and where m is $-(CH_2)_n-$ and where n is an integer in
11 the range of from 0 to 4; and wherein when r is -H, at least one of q₁, q₂,
12 q₃ and q₄ is also -H.

13 33. The article of manufacture of claim 30, wherein the polymeric backbone
14 comprises monomers selected from the group consisting of ethylene and
15 styrene.

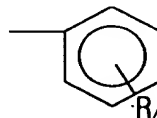
16 34. The article of manufacture of claim 30, wherein the cyclic olefinic
17 pendent groups are grafted onto the linking groups of the polymeric
18 backbone by a esterification, transesterification, amidation or
19 transamidation reaction.

- 1 35. The article of manufacture of claim 34, wherein the esterification,
2 transesterification, amidation or transamidation reaction is a solution
3 reaction or a reactive extrusion.
- 4 36. The article of manufacture of claim 34, wherein the esterification,
5 transesterification, amidation or transamidation reaction is catalyzed by
6 a catalyst selected from the group consisting of strong non-oxidizing
7 acids, tertiary amines, Group I alkoxides, Group IVB alkoxides, and
8 Group IVA organometallics.
- 9 37. The article of manufacture of claim 36, wherein the catalyst is selected
10 from the group consisting of toluene sulfonic acid, sodium methoxide,
11 tetrabutyl titanate, tetraisopropyl titanate, tetra-n-propyl-titanate,
12 tetraethyl titanate, 2-hydroxy-pyridine and dibutyltin dilaurate.
- 13 38. The article of manufacture of claim 30, wherein the backbone, linking
14 groups and cyclic olefin pendent groups comprise repeating units, each
15 unit having a structure (II) as follows:



(II)

wherein $P+T+Q$ is 100 mol % of the total composition; P is greater than 0 mol % of the total composition; Z is selected from the group consisting of an aryl group, $-(C=O)OR_1$, $-O(C=O)R_1$ and an alkyl aryl group:



where R_4 is selected from the group consisting of $-CH_3$, $-C_2H_5$, and $-H$; R_1 is selected from the group consisting of $-H$, $-CH_3$, $-C_2H_5$, $-C_3H_7$ and $-C_4H_9$; R_2 and R_3 are selected from the group consisting of $-H$ and CH_3 ; X is selected from the group consisting of $O-$, $-NH-$, $-(C=O)O-$, $-(C=O)NH-$, $-(C=O)S-$, $-O(C=O)-$ and $-(CHR)_\ell$; ℓ is an integer selected from the group consisting of 1, 2, 3, 4, 5 and 6; Y is $-(CHR)_n$, where n is an integer in the range from 0 to 12 and R is selected from the group consisting of $-H$, $-CH_3$ and C_2H_5 ; and where q_1 , q_2 , q_3 , q_4 , and r are selected from the group consisting of $-H$, $-CH_3$, and $-C_2H_5$; and where m is $-(CH_2)_n$ and where n is an integer in the range of from 0 to 4; and wherein when r is $-H$, at least one of q_1 , q_2 , q_3 , and q_4 is $-H$.

39. The article of manufacture of claim 30, wherein the cyclic olefinic pendent groups are selected from the group consisting of cyclohexene-4-methylene radical, 1-methyl cyclohexene-4-methylene radical, 2-methyl cyclohexene-4-methylene radical, 5-methyl cyclohexene-4-methylene radical, 1,2-dimethyl cyclohexene-4-methylene radical, 1,5-dimethyl cyclohexene-4-methylene radical, 2,5-dimethyl cyclohexene-4-methylene radical, 1,2,5-trimethyl cyclohexene-4-methylene radical, cyclohexene-4-ethylene radical, 1-methyl cyclohexene-4-ethylene radical, 2-methyl cyclohexene-4-ethylene radical, 5-methyl cyclohexene-4-ethylene radical, 1,2-dimethyl

cyclohexene-4-ethylene radical, 1,5-dimethyl cyclohexene-4-ethylene radical, 2,5-dimethyl cyclohexene-4-ethylene radical, 1,2,5-trimethyl cyclohexene-4-ethylene radical, cyclohexene-4-propylene radical, 1-methyl cyclohexene-4-propylene radical, 2-methyl cyclohexene-4-propylene radical, 5-methyl cyclohexene-4-propylene radical, 1,2-dimethyl cyclohexene-4-propylene radical, 1,5-dimethyl cyclohexene-4-propylene radical, 2,5-dimethyl cyclohexene-4-propylene radical, 1,2,5-trimethyl cyclohexene-4-propylene radical, cyclopentene-4-methylene radical, 1-methyl cyclopentene-4-methylene radical, 3-methyl cyclopentene-4-methylene radical, 1,2-dimethyl cyclopentene-4-methylene radical, 3,5-dimethyl cyclopentene-4-methylene radical, 1,3-dimethyl cyclopentene-4-methylene radical, 2,3-dimethyl cyclopentene-4-methylene radical, 1,2,3-trimethyl cyclopentene-4-methylene radical, 1,2,3,5-tetramethyl cyclopentene-4-methylene radical, cyclopentene-4-ethylene radical, 1-methyl cyclopentene-4-ethylene radical, 3-methyl cyclopentene-4-ethylene radical, 1,2-dimethyl cyclopentene-4-ethylene radical, 3,5-dimethyl cyclopentene-4-ethylene radical, 1,3-dimethyl cyclopentene-4-ethylene radical, 2,3-dimethyl cyclopentene-4-ethylene radical, 1,2,3-trimethyl cyclopentene-4-ethylene radical, 1,2,3,5-tetramethyl cyclopentene-4-ethylene radical, cyclopentene-4-propylene radical, 1-methyl cyclopentene-4-propylene radical, 3-methyl cyclopentene-4-propylene radical, 1,2-dimethyl cyclopentene-4-propylene radical, 3,5-dimethyl cyclopentene-4-propylene radical, 1,3-dimethyl cyclopentene-4-propylene radical, 2,3-dimethyl cyclopentene-4-propylene radical, 1,2,3-trimethyl cyclopentene-4-propylene radical, and 1,2,3,5-tetramethyl cyclopentene-4-propylene radical.

40. The article of manufacture of claim 30, wherein the composition is an ethylene/methyl acrylate/cyclohexenyl methyl acrylate terpolymer, a cyclohexenyl methyl acrylate/ethylene copolymer, a cyclohexenyl methyl methacrylate/styrene copolymer, a cyclohexenyl methyl acrylate

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1 homopolymer or a methyl acrylate/cyclohexenyl methyl acrylate
2 copolymer.

3 41. The article of manufacture according to claim 30, wherein the transition
4 metal catalyst is a metal salt.

5 42. The article of manufacture according to claim 41, wherein the metal in
6 the metal salt is cobalt.

7 43. The article of manufacture of according to claim 41, wherein the metal
8 salt is selected from the group consisting of cobalt neodecanoate, cobalt
9 2-ethylhexanoate, cobalt oleate and cobalt stearate.

10 44. The article of manufacture of claim 30, further comprising at least one
11 triggering material to enhance initiation of oxygen scavenging.

12 45. The article of manufacture of claim 44, wherein the triggering material is
13 a photoinitiator.

14 46. The article of manufacture of claim 30, wherein odor and taste
15 characteristics of products packaged with material comprised of the
16 composition are not adulterated as a result of oxidation of the
17 composition.

18 47. The article of manufacture of claim 30, wherein there is no significant
19 fragmentation of the olefinic pendent groups and linking groups from the
20 polymeric backbone as a result of oxidation of the composition.

21 48. The article of manufacture of claim 30 wherein the article is a package.

22 49. The article of manufacture of claim 48, wherein the package comprises a
23 flexible film having a thickness of at most 10 mil or a flexible sheet
24 having a thickness of at least 10 mil.

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- 1 50. The article of manufacture of claim 48, wherein the oxygen scavenging
2 system of the package comprises at least one additional layer selected
3 from among oxygen barrier layers, polymeric selective layers, and heat
4 seal layers.
- 5 51. The article of manufacture of claim 48, wherein the article is a package
6 with a food product located within the package.
- 7 52. The article of manufacture of claim 48, wherein the article is a package
8 for packaging a cosmetic, chemical, electronic device, pesticide or a
9 pharmaceutical composition.
- 10 53. A multi-layer film comprising the article of manufacture according to
11 claim 50, and at least one additional functional layer.
- 12 54. The multi-layer film according to claim 53, wherein at least one
13 additional layer is selected from among oxygen barrier layers, polymeric
14 selective barrier layers, structural layers and heat seal layers.
- 15 55. The multi-layer film according to claim 53, wherein the at least one
16 additional layer is an oxygen barrier layer.
- 17 56. The multi-layer film according to claim 55, further comprising at least one
18 polymeric selective barrier layer.
- 19 57. The multi-layer film according to claim 55, further comprising at least one
20 heat seal layer.
- 21 58. The multi-layer film according to claim 55, further comprising at least one
22 structural layer.

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1 59. The article of claim 30, wherein the article is a rigid container, sealing
2 gasket, patch, container closure device, bottle cap, bottle cap insert or
3 molded or thermoformed shape.

4 60. The article of claim 59, wherein the molded or thermoformed shape is a
5 bottle or tray.

6 61. A layer suitable for scavenging oxygen comprising:

7 (a) a polymer backbone;

8 (b) cyclic olefinic pendent groups;

9 (c) linking groups linking the backbone with the pendent groups; and

10 (d) a transition metal catalyst.

11 62. The layer of claim 61, wherein odor and taste characteristics of products
12 packaged with material comprised of the layer are not adulterated as a
13 result of oxidation of the layer.

14 63. The layer of claim 61, wherein there is no significant fragmentation of the
15 olefinic pendent groups and linking groups from the polymeric backbone
16 as a result of oxidation of the layer.

17 64. A layer according to claim 61, wherein the transition metal catalyst is a
18 metal salt.

19 65. A layer according to claim 64, wherein the transition metal in the metal
20 salt is cobalt.

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- 1 66. A layer according to claim 64, wherein the metal salt selected from the
2 group consisting of cobalt neodecanoate, cobalt 2-ethylhexanoate,
3 cobalt oleate and cobalt stearate.
- 4 67. A layer according to claim 61, wherein said layer in addition comprises
5 polymeric diluent.
- 6 68. A layer according to claim 67, wherein said diluent is a thermoplastic
7 polymer.
- 8 69. A layer according to claim 61, wherein said layer is adjacent to one or
9 more additional layers.
- 10 70. A layer according to claim 69, wherein at least one additional layer is an
11 oxygen barrier.
- 12 71. A layer according to claim 70, wherein said oxygen barrier comprises a
13 member of the group consisting of poly(ethylene-vinyl alcohol),
14 polyacrylonitrile, poly(vinyl chloride), polyamides, poly(vinylidene
15 dichloride), poly(ethylene terephthalate), silica, metal foil and metalized
16 polymeric films.
- 17 72. A layer according to claim 69, wherein one or more of said additional
18 layer or layers is coextruded with said layer.
- 19 73. A layer according to claim 69, wherein one or more of said additional
20 layer or layers is laminated onto said layer.
- 21 74. A layer according to claim 69, wherein one or more of said additional
22 layer or layers is coated onto said layer.
- 23 75. A layer according to claim 69, wherein said layer is flexible.

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1 76. A layer according to claim 69, wherein said layer is transparent.

2 77. An article for packaging wherein the article comprises a layer according
3 to claim 61.

4 78. A process of making a polymer material by a process selected from the
5 group consisting of esterification, transesterification, amidation,
6 transamidation and direct polymerization, wherein the polymer material
7 comprises a polymer backbone, cyclic olefinic pendent groups, linking
8 groups linking the backbone with the pendent groups.

9 79. The process of claim 78, wherein making the polymer material
10 comprises the steps of:

11 (a) selecting polymers from the group consisting of styrene/maleic
12 anhydride, ethylene/maleic anhydride, ethylene/acrylic acid,
13 ethylene/methacrylic acid, acrylic acid, methacrylic acid,
14 styrene/methacrylic acid, ethylene/methyl acrylate, ethylene/ethyl
15 acrylate, ethylene/butyl acrylate, methyl methacrylate, methyl
16 acrylate, and styrene/methyl methacrylate to form a mixture and
17 combining the polymers with a esterifying/transesterifying
18 compound selected from the group consisting of cyclohexene-4-
19 methanol, 1-methyl cyclohexene-4-methanol, 2-methyl
20 cyclohexene-4-methanol, 5-methyl cyclohexene-4-methanol, 1,2-
21 dimethyl cyclohexene-4-methanol, 1,5-dimethyl cyclohexene-4-
22 methanol, 2,5-dimethyl cyclohexene-4-methanol, 1,2,5-trimethyl
23 cyclohexene-4-methanol, cyclohexene-4-ethanol, 1-methyl
24 cyclohexene-4-ethanol, 2-methyl cyclohexene-4-ethanol, 5-methyl
25 cyclohexene-4-ethanol, 1,2-dimethyl cyclohexene-4-ethanol, 1,5-
26 dimethyl cyclohexene-4-ethanol, 2,5-dimethyl cyclohexene-4-
27 ethanol, 1,2,5-trimethyl cyclohexene-4-ethanol, cyclohexene-4-
28 propanol, 1-methyl cyclohexene-4-propanol, 2-methyl cyclohexene-

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4-propanol, 5-methyl cyclohexene-4-propanol, 1,2-dimethyl
cyclohexene-4-propanol, 1,5-dimethyl cyclohexene-4-propanol,
2,5-dimethyl cyclohexene-4-propanol, 1,2,5-trimethyl cyclohexene-
4-propanol, cyclopentene-4-methanol, 1-methyl cyclopentene-4-
methanol, 3-methyl cyclopentene-4-methanol, 1,2-dimethyl
cyclopentene-4-methanol, 3,5-dimethyl cyclopentene-4-methanol,
1,3-dimethyl cyclopentene-4-methanol, 2,3-dimethyl cyclopentene-
4-methanol, 1,2,3-trimethyl cyclopentene-4-methanol, 1,2,3,5-
tetramethyl cyclopentene-4-methanol, cyclopentene-4-ethanol, 1-
methyl cyclopentene-4-ethanol, 3-methyl cyclopentene-4-ethanol,
1,2-dimethyl cyclopentene-4-ethanol, 3,5-dimethyl cyclopentene-4-
ethanol, 1,3-dimethyl cyclopentene-4-ethanol, 2,3-dimethyl
cyclopentene-4-ethanol, 1,2,3-trimethyl cyclopentene-4-ethanol,
1,2,3,5-tetramethyl cyclopentene-4-ethanol, cyclopentene-4-
propanol, 1-methyl cyclopentene-4-propanol, 3-methyl
cyclopentene-4-propanol, 1,2-dimethyl cyclopentene-4-propanol,
3,5-dimethyl cyclopentene-4-propanol, 1,3-dimethyl cyclopentene-
4-propanol, 2,3-dimethyl cyclopentene-4-propanol, 1,2,3-trimethyl
cyclopentene-4-propanol, and 1,2,3,5-tetramethyl cyclopentene-4-
propanol;

- (b) heating the polymers and esterifying/transesterifying compounds
selected in (a) to form a polymer melt;
- (c) processing the melt in an extruder under
esterification/transesterification conditions with
esterification/transesterification catalysts and antioxidants
protecting the melt from oxidation during extrusion, so that the
polymer melt undergoes esterification of polymeric anhydrides with
cyclic olefin pendent groups, esterification of polymeric acids with
cyclic olefin pendent groups or exchange of alkyl groups of
polymeric esters with cyclic olefin pendent groups; and

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1 (d) removing volatile organic products and by-products from the melt.

2 80. The process of claim 78, wherein making the polymer material
3 comprises the steps of:

4 (a) selecting polymers from the group consisting of styrene/maleic
5 anhydride, ethylene/maleic anhydride, ethylene/acrylic acid,
6 ethylene/methacrylic acid, acrylic acid, methacrylic acid,
7 styrene/methacrylic acid, ethylene/methyl acrylate, ethylene/ethyl
8 acrylate, ethylene/butyl acrylate, methyl methacrylate, methyl
9 acrylate, and styrene/methyl methacrylate to form a mixture and
10 combining the polymers with a amidizing/transamidizing compound
11 selected from the group consisting of cyclohexene-4-methyl amine,
12 1-methyl cyclohexene-4-methyl amine, 2-methyl cyclohexene-4-
13 methyl amine, 5-methyl cyclohexene-4-methyl amine, 1,2-dimethyl
14 cyclohexene-4-methyl amine, 1,5-dimethyl cyclohexene-4-methyl
15 amine, 2,5-dimethyl cyclohexene-4-methyl amine, 1,2,5-trimethyl
16 cyclohexene-4-methyl amine, cyclohexene-4-ethyl amine, 1-methyl
17 cyclohexene-4-ethyl amine, 2-methyl cyclohexene-4-ethyl amine,
18 5-methyl cyclohexene-4-ethyl amine, 1,2-dimethyl cyclohexene-4-
19 ethyl amine, 1,5-dimethyl cyclohexene-4-ethyl amine, 2,5-dimethyl
20 cyclohexene-4-ethyl amine, 1,2,5-trimethyl cyclohexene-4-ethyl
21 amine, cyclohexene-4-propyl amine, 1-methyl cyclohexene-4-
22 propyl amine, 2-methyl cyclohexene-4-propyl amine, 5-methyl
23 cyclohexene-4-propyl amine, 1,2-dimethyl cyclohexene-4-propyl
24 amine, 1,5-dimethyl cyclohexene-4-propyl amine, 2,5-dimethyl
25 cyclohexene-4-propyl amine, 1,2,5-trimethyl cyclohexene-4-propyl
26 amine, cyclopentene-4-methyl amine, 1-methyl cyclopentene-4-
27 methyl amine, 3-methyl cyclopentene-4-methyl amine, 1,2-dimethyl
28 cyclopentene-4-methyl amine, 3,5-dimethyl cyclopentene-4-methyl
29 amine, 1,3-dimethyl cyclopentene-4-methyl amine, 2,3-dimethyl
30 cyclopentene-4-methyl amine, 1,2,3-trimethyl cyclopentene-4-

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methyl amine, 1,2,3,5-tetramethyl cyclopentene-4-methyl amine, cyclopentene-4-ethyl amine, 1-methyl cyclopentene-4-ethyl amine, 3-methyl cyclopentene-4-ethyl amine, 1,2-dimethyl cyclopentene-4-ethyl amine, 3,5-dimethyl cyclopentene-4-ethyl amine, 1,3-dimethyl cyclopentene-4-ethyl amine, 2,3-dimethyl cyclopentene-4-ethyl amine, 1,2,3-trimethyl cyclopentene-4-ethyl amine, 1,2,3,5-tetramethyl cyclopentene-4-ethyl amine, cyclopentene-4-propyl amine, 1-methyl cyclopentene-4-propyl amine, 3-methyl cyclopentene-4-propyl amine, 1,2-dimethyl cyclopentene-4-propyl amine, 3,5-dimethyl cyclopentene-4-propyl amine, 1,3-dimethyl cyclopentene-4-propyl amine, 2,3-dimethyl cyclopentene-4-propyl amine, 1,2,3-trimethyl cyclopentene-4-propyl amine, and 1,2,3,5-tetramethyl cyclopentene-4-propyl amine;

- (b) heating the polymers and amidizing/transamidizing compounds selected in (a) to form a polymer melt;
- (c) processing the melt in an extruder under amidation/transamidation conditions with amidation/transamidation catalysts and antioxidants protecting the melt from oxidation during extrusion, so that the polymer melt undergoes amidation of polymeric anhydrides with cyclic olefin pendent groups, amidation of polymeric acids with cyclic olefin pendent groups or exchange of alkyl groups of polymeric esters with cyclic olefin pendent groups; and
- (d) removing volatile organic products and by-products from the melt.

81. The process of claim 78, wherein the making of the polymer material comprises the steps of:

- 1 (a) adding to an autoclave, ethylene and a vinyl monomer comprising
2 a pendent cyclohexene;
- 3 (b) stirring the ethylene and the vinyl monomer in the autoclave to
4 achieve a mixture;
- 5 (c) adding a polymerization initiator before, during or after the stirring
6 step;
- 7 (d) polymerizing the mixture to achieve a polymer; and
- 8 (e) isolating and purifying the polymer.

9 82. The process of claim 81, wherein in step (a) an alpha-olefin is added to
10 the autoclave along with the ethylene and the vinyl monomer and in
11 step (b) the alpha-olefin is stirred with the ethylene and the vinyl
12 monomer to achieve the mixture.

13 83. The process of claim 79, wherein the polymeric backbone is ethylenic
14 and the linking groups are selected from the group consisting of:

15 $-\text{O}-(\text{CHR})_n-$; $-(\text{C}=\text{O})-\text{O}-(\text{CHR})_n-$; $-\text{NH}-(\text{CHR})_n-$;

16 $-\text{O}-(\text{C}=\text{O})-(\text{CHR})_n-$; $-(\text{C}=\text{O})-\text{NH}-(\text{CHR})_n-$; and

17 $-(\text{C}=\text{O})-\text{O}-\text{CHOH}-\text{CH}_2-\text{O}-$;

18 where R is hydrogen or an alkyl group selected from the group
19 consisting of methyl, ethyl, propyl and butyl groups and where n is an
20 integer in the range from 1 to 12.

21 84. The process of claim 80, wherein the polymeric backbone is ethylenic
22 backbone and the linking group is:

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1 $-(C=O)-NH-(CHR)_n$

2 where R is hydrogen or an alkyl group selected from the group
3 consisting of methyl, ethyl, propyl and butyl groups and where n is an
4 integer in the range from 1 to 12.

5 85. The process of claim 78, wherein the material is an oxygen scavenging
6 composition further comprising a transition metal catalyst.

7 86. The process of claim 85, wherein the transition metal catalyst is a metal
8 salt.

9 87. The process of claim 86, wherein the metal in the metal salt is cobalt.

10 88. The process according to claim 86, wherein the metal salt is selected
11 from the group consisting of cobalt neodecanoate, cobalt
12 2-ethylhexanoate, cobalt oleate and cobalt stearate.

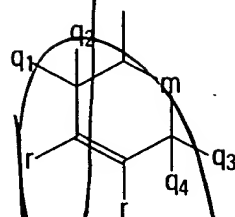
13 89. The process of claim 85, wherein the oxygen scavenging composition
14 further comprises at least one triggering material to enhance initiation of
15 oxygen scavenging.

16 90. The process of claim 89, wherein the triggering material is a
17 photoinitiator.

18 91. The process of claim 78, wherein the cyclic olefinic pendent groups have
19 the structure (I):

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(I)

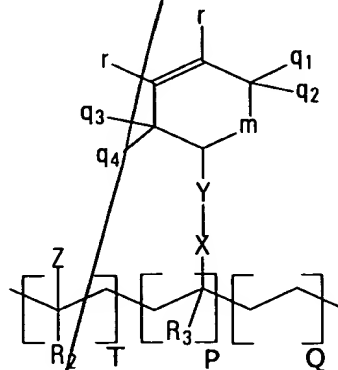


where q_1 , q_2 , q_3 , q_4 , and r are selected from the group consisting of $-H$, $-CH_3$, and $-C_2H_5$; and where m is $-(CH_2)_n-$ and where n is an integer in the range of from 0 to 4; and wherein when r is $-H$, at least one of q_1 , q_2 , q_3 and q_4 is $-H$.

92. The process of claim 78, wherein the functional groups with attached cyclic olefinic pendent groups are grafted onto the linking backbone by a esterification, transesterification, amidation or transamidation reaction.
93. The process of claim 78, wherein the reaction is a solution reaction or a reactive extrusion.
94. The process of claim 78, wherein the esterification, transesterification, amidation or transamidation reaction is catalyzed by a catalyst selected from the group consisting of strong non-oxidizing acids, tertiary amines, Group I alkoxides, Group IVB alkoxides, Group IVA organometallics.
95. The process of claim 94, wherein the catalyst is selected from the group consisting of toluene sulfonic acid, sodium methoxide, tetrabutyl titanate, tetraisopropyl titanate, tetra-n-propyl-titanate, tetraethyl titanate, 2-hydroxy-pyridine and dibutyltin dilaurate.

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- 1 96. The process of claim 78, wherein the backbone, linking groups and
 2 cyclic olefin pendent groups comprise repeating units, each unit having a
 3 structure (II) as follows:



4

5 wherein P + T + Q is 100 mol % of the total composition; P is greater
 6 than 0; Z is selected from the group consisting of an aryl group,
 7 $-(C=O)OR_1$, $-O(C=O)R_1$ and an alkyl aryl group:

8

9 where R_4 is selected from the group consisting of $-H$, $-CH_3$ and $-C_2H_5$; R_1
 10 is selected from the group consisting of $-H$, $-CH_3$, $-C_2H_5$, $-C_3H_5$ and
 11 $-C_4H_7$; R_2 and R_3 is selected from the group consisting of $-H$ and CH_3 ; X
 12 is selected from the group consisting of $O-$, $-NH-$, $-(C=O)O-$, $-(C=O)NH-$,
 13 $-(C=O)S-$, $-O(C=O)-$ and $-(CHR)_\ell$; ℓ is an integer selected from the
 14 group consisting of 1, 2, 3, 4, 5 and 6; Y is $-(CHR)_n$, where n is an
 15 integer in the range from 0 to 12 where R is selected from the group
 16 consisting of $-H$, $-CH_3$ and $-C_2H_5$; where q_1 , q_2 , q_3 , q_4 , and r are selected

from the group consisting of -H, -CH₃, and -C₂H₅; and where m is -(CH₂)_n- and where n is an integer in the range of from 0 to 4; and wherein when r is -H, at least one of q₁, q₂, q₃ and q₄ is -H.

97. The process of claim 78, wherein the cyclic olefinic pendent groups are selected from the group consisting of cyclohexene-4-methylene radical, 1-methyl cyclohexene-4-methylene radical, 2-methyl cyclohexene-4-methylene radical, 5-methyl cyclohexene-4-methylene radical, 1,2-dimethyl cyclohexene-4-methylene radical, 1,5-dimethyl cyclohexene-4-methylene radical, 2,5-dimethyl cyclohexene-4-methylene radical, 1,2,5-trimethyl cyclohexene-4-methylene radical, cyclohexene-4-ethylene radical, 1-methyl cyclohexene-4-ethylene radical, 2-methyl cyclohexene-4-ethylene radical, 5-methyl cyclohexene-4-ethylene radical, 1,2-dimethyl cyclohexene-4-ethylene radical, 1,5-dimethyl cyclohexene-4-ethylene radical, 2,5-dimethyl cyclohexene-4-ethylene radical, 1,2,5-trimethyl cyclohexene-4-ethylene radical, cyclohexene-4-propylene radical, 1-methyl cyclohexene-4-propylene radical, 2-methyl cyclohexene-4-propylene radical, 5-methyl cyclohexene-4-propylene radical, 1,2-dimethyl cyclohexene-4-propylene radical, 1,5-dimethyl cyclohexene-4-propylene radical, 2,5-dimethyl cyclohexene-4-propylene radical, 1,2,5-trimethyl cyclohexene-4-propylene radical, cyclopentene-4-methylene radical, 1-methyl cyclopentene-4-methylene radical, 3-methyl cyclopentene-4-methylene radical, 1,2-dimethyl cyclopentene-4-methylene radical, 3,5-dimethyl cyclopentene-4-methylene radical, 1,3-dimethyl cyclopentene-4-methylene radical, 2,3-dimethyl cyclopentene-4-methylene radical, 1,2,3-trimethyl cyclopentene-4-methylene radical, 1,2,3,5-tetramethyl cyclopentene-4-methylene radical, cyclopentene-4-ethylene radical, 1-methyl cyclopentene-4-ethylene radical, 3-methyl cyclopentene-4-ethylene radical, 1,2-dimethyl cyclopentene-4-ethylene radical, 3,5-dimethyl cyclopentene-4-ethylene radical, 1,3-dimethyl cyclopentene-4-ethylene radical, 2,3-dimethyl cyclopentene-4-ethylene

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10 98. The process of claim 78, wherein the composition is a ethylene/methyl
11 acrylate/cyclohexenyl methyl acrylate terpolymer, a cyclohexenyl methyl
12 acrylate/ethylene copolymer, a cyclohexenyl methyl
13 methacrylate/styrene copolymer, a cyclohexenyl methyl acrylate
14 homopolymer or a methyl acrylate/cyclohexenyl methyl acrylate
15 copolymer.